rens. A sound land-policy, therefore, demands that the nation should give earnest attention to forest management.

"It has become evident that we are not to escape the consequences of disturbing the even distribution of water-flow by forest devastation, and denudation of mountains and hills, which have been experienced in other parts of the world, and which have reduced fertile lands to barrenness, prosperous communities to poverty. Regard, therefore, for the future welfare of the several communities which in their aggregate represent the nation, calls for a rational forest policy, a proper utilization, a proper distribution, and a proper management of the natural forest.

"Lastly, if the nation as such is interested in the proper development of the rich agricultural lands of the plains and prairies, it must be interested also — in that part of its domain, at least — in forest-planting as a means of ameliorating climatic conditions and making the region more habitable."

Mr. Fernow then proceeds to consider the most immediate needs and the most immediate duty of the general government in regard to the forestry question. "The general government still holds, as an individual, national property, a forest area the extent of which is unknown, but may be estimated between fifty and seventy million acres. The bulk of these lands is to be found on the rugged mountain sides and crests of the Western ranges, notably the Rocky Mountain, Cascade, Sierra Nevada, and Pacific coast ranges, mostly land not fit for agricultural use. The agricultural valleys at the foot of these ranges are not only destitute of timber, but they are dependent for their agricultural productions upon irrigation, the water for which is derived from the mountain-streams and more rarely from artesian wells, both of which sources are fed by the rains and snows which fall upon the forest-covered mountain-sides, and gradually find their way to the plain below. It has been proved not only by experience, but by actual experiment on a large scale, that forest cover regulates and beneficially influences the rapidity with which these precipitations are carried to the plain for utilization on agricultural lands."

In order to preserve these woods, a bill has been formulated, which has been submitted to Congress through the agency of the American Forestry Congress. Its essential features are the withdrawal from sale, or other disposal, of all woodlands still in the hands of the government, and the classification of the same into three classes; the regulation of the sale of timbered land which is fit for agriculture; and the management of the forests occupying land unfit for agriculture. To insure a proper administration of such a law, to prevent waste and loss by fires, a new bureau in the Department of the Interior is proposed, with a forest commissioner and four assistant commissioners acting as a forestry board.

"None but such a thorough organization can be expected to guard the national property, of which, under the present neglect, the nation is annually robbed to the extent of from five to ten million dollars, not counting the damage done by fires and fraudulent operations of speculators. But, as has been stated repeatedly, the forest-cover in the localities in which the bulk of the public timber-lands is situated, notably on the Rocky Mountains and the Pacific slopes, subserve a function which makes its material value of only secondary importance. It has become already evident that the denudation of mountain-sides in the region under consideration has impaired the regularity of water-flow, upon which irrigation in the arid valleys below depends.

"The interest of the nation, therefore, in properly administering this property, reaches beyond that of any material advantage; and certainly in these mountain forests, in this legislation for their proper administration, lies the immediate national interest in forestry."

ELECTRICAL SCIENCE.

The Heroult Aluminium Process.

THE Swiss Metallurgical Company, established close to the Rhine Fall at Neuhausen, has adopted the process of M. Heroult for the production of alloys of aluminium. The process resembles in some ways that of the Cowles brothers, which is so successfully employed at Lockport in the United States, and which has been recently introduced in England and the continent. In both the Cowles and Heroult processes an electric current is employed. In the former it is used simply to produce a very high temperature in a limited zone, the reduction of the ore being due to the temperature alone and not to any effect of electrolysis, so that an alternating could be used as well as a continuous current. In the Heroult process, according to the views of the inventor, the reduction of the ore is partly electrolytic and partly due to the heat of the arc. The furnace has a carbon pole at the top, and the current passes in by it through the melted aluminium oxide to the reduced metal at the bottom; the ore is decomposed, the oxygen passing upward and attacking the carbon, while the molecules of the metal travel downward and are merged in the metal bath.

The furnace used in the process is a large carbon block hollowed out in the proper shape and enclosed by a frame of iron. In the smaller furnaces a single block of carbon is used and the iron is cast around it; for larger sizes slabs of carbon are used, and are held together by wrought-iron bands. There is an opening in the bottom of the furnace for drawing off the reduced metal. The current enters the crucible through a carbon electrode which enters the top, and which consists of a bundle of carbon slabs, ten feet long, seventeen inches wide, and nine and a half inches deep. The distance of this electrode from the surface of the molten metal is regulated by an attendant. This distance is very small, preferably not over a quarter of an inch. One of the electrodes is consumed in producing about half a ton of aluminium. The crucible is covered by carbon slabs insulated from the body of the crucible; in the top, holes are provided for the introduction of ore and scrap metal. The ore generally used is alumina, free from silicon and other impurities, and the scrap metal is either iron or copper, according to the alloy which is desired. The process of smelting is a continuous one, the ore being introduced and the crucible tapped at regular intervals. The production of aluminium per horse-power hour varies somewhat with the percentage of the metal contained in the alloy, the average being thirty grams of aluminium and the maximum being forty grams. That is, to produce one pound of aluminium requires fifteen horse-power hours on the average, and eleven horse-power hours under favorable conditions. The present capacity of the crucible is four hundredweight of aluminium in twenty-four hours.

At the works at Neuhausen the current is produced by two dynamos driven by a turbine of three hundred horse-power. These dynamos are of the multipolar type, designed by Mr. C. E. L. Brown, and built at the Oerlikon Engineering Works. They are designed to give six thousand ampères each, at an electromotive force of twenty volts, and they can be worked up to thirty-five volts. The speed of the turbine is controlled by an automatic regulator acting upon a throttle in the inlet-pipe of the turbine. While the working current is normally twelve thousand ampères, it sometimes increases to twenty thousand ampères, because of a short-circuit in the furnace, caused usually by one of the slabs of which the carbon electrode is made burning more slowly than the others and touching the surface of the molten metal. This increase of current does not injuriously affect the dynamos. There is no sparking at the brushes of the dynamos. The process promises to be a successful one; from the figures given it compares favorably with the Cowles process in the amount of aluminium reduced per horse-power.

AN IMMENSE ELECTRIC LIGHTING STATION. — In the London *Electrical Review* is a description of the station of the London Electric Supply Corporation. At the Stowage wharf, Deptford, this corporation is laying down plant sufficient for the supply of 250,000 incandescent lamps, and there is space for three other sets similar to the first, giving a final capacity of one million lamps. The grounds of the corporation have a river frontage, with a wharf for landing fuel and heavy machinery. A fifty-ton derrick has already been erected. The buildings occupy a space of 210 by 195 feet, and the height will be 100 feet.

The boiler house is 195 by 70 feet, and is constructed to hold boilers of 65,000 horse-power, and of these, 13,000 horse-power are being erected. The boilers will occupy the two lower floors, with stowage room above for the fuel. The two engine houses are of nearly the same dimensions as the boiler house, and are very massive in construction. In the first of these houses a pair of 3,000

horse-power engines will soon be erected, and will drive two Ferranti dynamos, each capable of supplying current for 25,000 lamps. These are the largest electric generators in the world, and we can get some idea of the increasing size of dynamos when we remember that four years ago the largest practical machines were Edison's 'Jumbo' dynamos of 1,200 lights capacity. In the second engine room will be placed two sets of engines and dynamos. These are combined in such a manner that the armatures of the dynamos are driven directly by the engines and act as their fly-wheels. The speed is but sixty revolutions per minute. There will be four dynamos, and they will finally have each a pair of 10,000 horse-power engines. At present they are to have but 5,000 horse-power each. All future extensions of plant will be in these units. The dynamos will weigh 500 tons, and the armatures will be 45 feet in diameter.

The distribution will be on the alternating current system. The current leaves the station at the enormous potential of 10,000 volts, and is taken to a number of distributing stations where a first conversion takes place, lowering the potential to one or two thousand volts; then it is taken to the points of consumption, where a second conversion takes place and the voltage is lowered to that necessary for the lamps.

The main cable, $2\frac{8}{8}$ inches in external diameter, is formed of two concentric tubes of copper. An insulating compound separates the two tubes, the central portion of the cable being hollow: the sectional area of each tube is .5 of a square inch.

The first two dynamos of 1.500 horse-power each are nearly completed, and will soon be erected; two of the 10,000 horse-power dynamos will probably be finished in about five months. The space now covered with buildings will accommodate 40,000 horse-power, and the rest of the space available can accommodate 80,000 horse-power more, a total capacity of 120,000 horse-power.

This station, in capacity and the enormous potential used (the maximum electromotive force is about 15,000 volts), far surpasses any thing that has been attempted in this country or anywhere else. It is hardly to be hoped that the scheme will succeed without great trouble and discouragement at first, since many of the conditions are new; but whether it finally fails or succeeds, the experience it will give will be of great benefit to electricians.

ELECTRO-DEPOSITED COPPER. — Messrs. Elmore, in England, have introduced a process for the production of pure copper tubes, wire, etc., by which very satisfactory results have been obtained. The general method of producing a tube is to immerse a revolving mandrel, nearly surrounded by bars of Chili copper, in a bath of copper sulphate, and send a current of electricity between the bars and the mandrel. The ordinary result would be the deposition of crystalline copper, with little adhesiveness and strength. The essential feature of the process is a burnisher pressing lightly on the surface of the copper, travelling on a leading screw from one end of the mandrel to the other, its motion being automatically reversed when it reaches either end. The result is a tube of great density and strength, and without lines of weakness as in ordinary tubes.

When it is desired to make wires, tubes of any desired length and thickness are cut spirally into square wires, and these are afterwards drawn to the required size and shape. The conductivity is greater than that usually obtained in commercial wire, and is even greater than that of the samples determined by Dr. Matthiessen, who used the greatest care in obtaining his specimens of copper. Tests made on annealed and hard-drawn wires give respectively 102.4 and 104.44 per cent of the conductivity obtained by Dr. Matthiessen for pure copper.

BOOK-REVIEWS.

Researches on Diamagnetism and Magne-Crystallic Action. By JOHN TYNDALL. New York, Appleton. 12°. $1.50.

WHEN Tyndall undertook the first of the researches contained in this volume, the attention of physicists had been drawn to the remarkable phenomena exhibited by certain substances, metals, and other matter, and by crystals when placed in a magnetic field. It was found that various substances, notably bismuth, were repelled by magnetic poles instead of being attracted; and it was stated that crystals in a magnetic field tended to take up a definite position, but were neither attracted nor repelled. With respect to the first of these phenomena, the questions which arose were, 'What is the nature of this diamagnetic force?' 'Does it correspond to magnetic force but with an opposite direction?' Faraday first thought that the phenomena might be explained by assuming in diamagnetic bodies a polarity the reverse of that in magnetic bodies; but he soon abandoned this view, and held that the apparent diamagnetism of bodies was caused by their being less magnetic than the medium in which they were placed. A diamagnetic body was with him a body less magnetic than air.

Tyndall, in these memoirs on the subject, has with great ingenuity, and with apparatus at once powerful and delicate, compared the deportment of diamagnetic with magnetic bodies; and "the antithesis between them, when acted on by all possible combinations of electro-magnets and electric currents, was proved to be absolute and complete. . . . No reasonable doubt, therefore, could rest upon the mind that the diamagnetic force possessed precisely the same claim to the title of polar force as the magnetic."

This work of Tyndall's was done over thirty years ago. The attention of physical scientists was called to other electrical and magnetic phenomena, and no really important experiments on magnetization were tried until 1872, when Stolltow and Rowland published their well-known researches. But in the last few years interest has again centred in magnetic phenomena, and it is well that attention should be called to earlier experiments.

The present edition of 'Diamagnetism and Magne-Crystallic Action' differs from the original in the omission of some parts that are of little interest now. As a clear description of difficult, ingenious, and successful experiment, it should form part of the library of every physicist.

Tales of the Birds. By W. WARDE FOWLER. London and New York, Macmillan. 12°. $2.50.

THIS book is hard to classify, being a series of eight fancy sketches, consisting of imaginary bird-talk, with little obvious point, and containing little that can be seriously called ornithological. It is designed, perhaps, to illustrate certain incidents of bird-life, as the hard struggle for existence of English field-fares in winter, the dangers and mishaps befalling birds during migration, etc. The birds are supposed to tell their own tales. The slight web of fact is heavily padded with light fancies, designed doubtless to interest especially juvenile readers, who may find the book somewhat attractive. The book is English in its scenes and subjects. The writer is obviously familiar with bird-ways, and might write well in a more serious vein. The eight full-page illustrations are quite in keeping with the general character of the text. The title of the book is about all that would suggest its classification as a natural-history publication.

A Manual of the Vertebrate Animals of the Northern United States. By DAVID STARR JORDAN. 5th ed. Chicago, A. C. McClurg & Co. 12°. $2.50.

THE present edition of President Jordan's well-known 'Manual' is much enlarged in scope, and so completely rewritten and rearranged as to be in many respects not only greatly improved, but practically a new work. The geograpical area is extended westward from the Mississippi River to the Missouri River, and the marine forms (excluding the deep-sea species and those of merely accidental occurrence) are for the first time included, the coast region thus covered extending from Nova Scotia to Cape Hatteras. The artificial keys of the former editions have in great part given place to analytical keys based on differential characters. While this change may render slightly more difficult the quick recognition of species by the inexperienced student, it has the advantage of making known more clearly the actual basis of classification. The order of succession of groups is also reversed, the lowest or more generalized standing first; the 'Manual' beginning with the fishes, and ending with the mammals. By the omission of synonymes and references, except in special cases, the use of smaller type and a larger type-bed, the amount of matter has been much increased, while the number of pages is lessened and the typographical appearance of the book greatly improved. In classification and nomenclature the work is fully abreast of the latest discoveries and conclusions in respect to